12. NIGHTCAP VILLAGE INVESTIGATION OF WATER SUPPLY AND EFFLUENT DISPOSAL OPTIONS

Cardno - 2006

Cardno
Engineering the Future

Nightcap Urban Village

Investigation of Water Supply and Effluent Disposal Options

27 July 2006
Job No. 3500/53

Peter Van Lieshout

Cardno (Qld) Pty Ltd

ABN 57 051 074 992

5 Gardner Close Milton Q 4064

PO Box 388 Toowong

Queensland 4066 Australia

Telephone: 07 3369 9822

Facsimile: 07 3369 9722

International: +61 7 3369 9822

Email: cardno@cardno.com.au

Web: www.cardno.com.au

Document Control

Version	Date	Author		Reviewer	
		Name	Initials	Name	Initials
1	19 May 2006	Greg Hausler	GH	M Chessells	MC
2	27 July 2006	Greg Hausler	GH	M Chessells	MC

"© 2006 Cardno (Qld) Pty Ltd All Rights Reserved. Copyright in the whole and every part of this document belongs to Cardno (Qld) Pty Ltd and may not be used, sold, transferred, copied or reproduced in whole or in part in any manner or form or in or on any media to any person without the prior written consent of Cardno (Qld) Pty Ltd."

NIGHTCAP URBAN VILLAGE

INVESTIGATION OF WATER SUPPLY AND EFFLUENT DISPOSAL OPTIONS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

EXECUTIVE SUMMARY

It is proposed to develop a site on Kyogle Road in the Kunghur area of north-eastern New South Wales to create a residential village. The site falls within the jurisdiction of Tweed Shire Council.

The development will be a rural village style comprising normal detached residential dwellings, village residential, mixed village development and community facilities, fully integrated into the surrounding environment.

This report describes an investigation into the water supply and sewerage infrastructure required for the development.

Water sensitive urban design principles have been observed in the proposal.

For the village lot housing area, rainwater tanks of 45 kilolitres minimum capacity per lot are recommended. Provided the full roof area is drained to the tanks, they will provide the full domestic requirements with a suitably high reliability of supply. Use of rainwater tanks will help to counteract the increases in runoff intensity that results from urbanisation.

For the mixed village, and village housing style development, rainwater tanks of minimum capacity 20 kilolitres are recommended. For the community facilities, a tank size of 10 kilolitres per 45 square metres of roof area is recommended. Because of the limited roof area in these types of development, rainwater supply will only provide about half of the domestic water demand with acceptable reliability; therefore a supplementary reticulated supply is proposed. Treated water supply from the two small storages located to the north of site will be reticulated to the dwellings. The supply from these two dams will provide 50% of the demand of the mixed village, village residential areas and community facilities with high reliability.

An option would could be considered is a separate reticulated supply of recycled water to the village lot housing, mixed residential, village residential, and community facilities to provide water for toilet flushing and outdoor uses. This has not been allowed for in water supply calculations, but if constructed, will reduce the demand on rainwater tanks and the surface water supplies.

The whole development will be sewered, and the effluent treated to a high standard (suitable for unrestricted irrigation, toilet flushing, and outdoor uses) by a treatment plant using membrane filtration, located to the north of the site. Recycled water from this plant will be used for irrigation of the sports oval, and village green areas, and also for other areas outside the site, including a proposed tree farm. An option exists for part of the treated effluent to be reticulated to dwellings for use in toilet flushing and outdoor uses.

An effluent irrigation area totalling approximately 13.5 hectares will be required, as well as a wet-weather storage of 6.6 megalitres capacity. Adequate areas exist outside of the development area for effluent irrigation. The location of the treatment plant with adequate buffer distances, and the high quality of effluent produced will ensure that there will be odour problems expected.

The proposed water supply and sewerage for the development represents a sustainable solution that will not require facilities external to the development, utilise existing storages, be environmentally compliant, and be in accord with the vision for the development.

1. INTRODUCTION

It is proposed to develop a site on Kyogle Road in the Kunghur area of north-eastern New South Wales to create a residential village. The site falls within the jurisdiction of Tweed Shire Council.

The existing site is characterised by pockets of woodland among open grassland. The development proposal includes residential lots of varying density, and accompanying sports, recreation, hotel and commercial areas. Most of the proposed development will be positioned some distance from the Tweed River which is close to the southern boundary of the site, as a riparian zone has been identified which will also form a buffer between the site and Kyogle Road. Figure 1 shows the location of the development, and Figure 2 is the concept master plan of the development. The riparian zone between the development and Tweed River s indicated on Figure 2.

The site is remote from any existing water supply reticulation area, therefore a water supply will be provided as part of the development. This report describes a preliminary investigation into the sewerage and water supply infrastructure requirements for the development, and from that investigation recommendations are made for the infrastructure required to provide an appropriate standard of service.

2. ESTIMATION OF DEMAND

2.1 Equivalent Population for Water Supply

Information is available on the type of development, and the proposed number of dwellings planned. Based on the most recent concept planning information, the table below lists the type of development, dwelling density and population for the ultimate development.

Table 1 Development types, dwelling and population

Development Type	Approximate Land Area Ha	Dwellings per ha	Yield	Typical Lot Size m^2
Village Lots - Low density residential - detached housing on larger lots	11	15	170	500 - 600
Village Housing - Low-medium density residential - detached, semi attached housing, townhouses, small lot housing	5.1	25	130	250 - 400
Mixed Village - Low-medium and medium density - semi-attached, detached, townhouses and units. Retail uses, hotel, backpackers	3.9	28	110	200 - 350
Tourism - Conference centre, health centre	0.5	20	10	200
Total no of Lots			420	
Predicted population @ 2.2 persons per dwelling			924	

It is understood that the low-density housing development will consist of detached dwellings on larger lot sizes.

The medium development will most likely consist of two or three story cluster housing on small lots, while the Mixed Village development will comprise two and three story dwellings with some commercial areas on the ground floors.

2.2 Water Use per EP

The water use per EP has been determined using the information from the standard for on-site domestic wastewater management (AS/NZS 1547:2000). Appendix 4.2D of that standard suggests a wastewater flow allowance of 140 litres/person/day for households supplied by on-site roof water tank supply or 180 litres/person/day for households supplied by reticulated community or a bore-water supply. In this development, the principal supply is proposed to be by rainwater tank, therefore 140 litres/person/day has been adopted for internal use.

Considering that these volumes are applicable to wastewater flows, the quantity should be increased by some nominal amount to represent the use component for drinking water, cooking, and cleaning. An amount of around 10 litres/person/day is considered appropriate.

For purposes of determining the water requirements for the development, a consumption of 150 litres/EP/day has therefore been used.

Rainwater tanks will provide the water supply to the low-density housing. It is probable that supplementary piped water supply may be provided for toilet flushing and external uses in the low-density housing area, but for the purposes of rainwater tank sizing in this investigation, it is assumed that rainwater tanks will provide the sole supply.

For the medium and mixed development types, a combination of rainwater tank supply and a supplementary supply will be necessary.

It may be possible to reduce the per EP consumption, by measures such as use of full water reduction facilities, however given the nature of the development, and the fact that water use information for similar types of developments with rainwater tank supplies is virtually non-existent, it is recommended that a consumption of 150 litres/EP/day be used for initial planning purposes.

It is recommended that water use for early stages of the development be monitored. This information could be used for more detailed water supply planning for later stages of the development, and appropriate measures could be taken to ensure sustainability of the supply.

2.3 Total Water Demand

The ultimate population of the development is proposed to be approximately 930 people, based on an average of 2.2 people per dwelling. The development will occur in three stages, and the staging plan is shown in Figure 3. Based on the staging plan, and the ultimate development, the water demand per stage and the ultimate water demand will be approximately as listed in the following table.

Table 2 Estimates of Water Demand

Stage	Development Type	Estimated EP*	Total Domestic Water Demand** (kL/day)	Reticulated Supply Component (kL/day)
Stage 1	Village Lots	246	36.9	-
	Village Housing	121	18.1	9.1
	Mixed Village	242	36.3	18.2
	Total Stage 1	**609**	**91.3**	**27.3**
Stage 2	Village Housing	128	19.2	-
	Village Housing	31	4.6	2.3
	Total Stage 2	**159**	**23.8**	**2.3**
Stage 3	Village Housing	134	20.1	10.1
	Tourism – Special Uses	50	7.5	3.7
	Total Stage 3	**184**	**27.6**	**13.8**
	Total	**952**	**142.7**	**43.6**

Note: * Assumes 2.2 EP per dwelling
** Internal domestic use

For development other than the village lots, it has been assumed that rainwater tanks will supply part of the demand, supplemented by the reticulated supply. The reticulated supply demands are included in Table 2.

3. RAINWATER TANK SUPPLY

Some analyses of the reliability of water supply from rainwater tanks have been carried out for the different types of development. The analysis has been based on a daily water balance for a single dwelling with a rainwater tank.

Daily rainfall information for the area (sourced from the Silo Datadrill interpolated daily rainfall database maintained by Qld Department of Natural Resources Mines & Water) for the historical period 1950 to 2005 was used in the analysis.

The reliability of supply was estimated for a range of combinations of rainwater tank size, roof contributing area, and daily water demand. In the analyses, it was assumed that the first 1 mm/day of rainfall was interception loss, and the next 0.2 mm was lost to a first flush device.

Appendix A is a summary of results for a range of roof areas, tank sizes and household demands. The results are expressed in the terms of (a) % time of shortfall, which is the % of time during the 56 year period that the supply would fail, and (b) the average annual shortfall in kilolitres.

3.1 Village Lot Development

For the low-density development, it is assumed that rainwater supply will be the sole supply.

The roof areas are expected to be fairly large for this type of development. Assuming that a roof area of 150 m^2 or greater can be drained to the rainwater tanks, a tank size of 45,000 litres (approx 10,000 gallons) or greater would be required to give an acceptable reliability of supply as a sole water supply.

For a roof area of 200 m^2 and tank volume of 45,000 litres, based on the water balance, very minor shortfalls in supply would have been experienced in 2 of the 56 years, therefore a tank (or tanks) with total capacity of 45,000 litres or greater will be desirable in this area, to provide a supply of adequate reliability.

It should be possible to accommodate a rainwater tank (or tanks) of total 45,000 litres or greater on these larger lot sizes.

3.2 Mixed Village and Village Housing Development

Roof area and sites available for rainwater tanks will be limited in this type of development, therefore some supplementary supply will be necessary. The supplementary supply is proposed to be treated supply from a number of existing and proposed small dams on or near the development site.

Based on typical patterns of domestic household usage, approximately half of the total domestic demand can be attributed to the kitchen and bath/shower usage. The remaining half of the demand is attributed to toilet and laundry usage.

It is proposed that dual plumbing be provided. Rainwater tank supply will provide for kitchen and bath/shower use, while the external supplementary supply will be piped to toilet and laundry.

With this arrangement, the demand from rainwater tanks per household is estimated to be about 165 litres/dwelling/day (about half the total demand).

If a roof catchment area of 90 m^2 per dwelling is assumed, a rainwater tank volume of 20,000 litres per lot will be required for an acceptably reliable supply. A 2.6-metre high 23,000 litre tank would take up an area of about 10.5 m^2.

It should be possible to integrate rainwater tanks with the proposed village type housing in the development. An option would be to provide a common rainwater tank storage to serve a group of houses, but this would require additional reticulation and collection pipework.

An option exists for the treated effluent from the development (recycled water) to be piped via a dual reticulation system to the mixed village and village housing development for toilet flushing and external uses. This would reduce the demand on the rainwater tank and reticulated supply, but would require additional pipework. For the purposes of sizing the rainwater tanks and estimating the supply required from the local water supply storages, it has been conservatively assumed that supply to the mixed village, village residential and community facilities is provided only by on-site rainwater tanks and the treated supply from local water storages.

4. SURFACE WATER SUPPLY

A supplementary supply is required for the village housing and mixed housing developments. The most logical additional supply would be from the existing and proposed dams in and near the development.

4.1 Small Dams

The existing dams are shown in Figure 4. Their details are as follows.

- "Muddy Dam", located to the west of the development site. It is understood that this storage could be utilised for water supply. Muddy Dam has a catchment area of approximately 9.2 hectares, and appears to have a volume of approximately 13 ML, although this would need to be confirmed by survey.
- A small storage ("Dam 3") located just north of the proposed low-density residential area. It is understood that this storage could be utilised for water supply. It has a catchment area of approximately 12.4 hectares, and appears to have a volume of approximately 10.6 ML, although this would need to be confirmed by survey.
- A larger storage ("Dam 4") located north of Dam 3. This is a recently constructed storage, which has a capacity of 55 ML. It has a catchment area of approximately 21 hectares. This storage could also be used for water supply purposes.

The two proposed storages within the development ("Dam 2" and "Dam 1") will have a combined volume of approximately 15.2 ML, based on the latest information. The catchment area of the most downstream of these storages is approximately 41.6 ha, while the upstream storage has a catchment area of approximately 37.8 hectares.

Part of the catchment area of these dams will include the village housing, mixed village, and low-density areas of the development. The contributing impervious area (including pavement, driveways etc, but excluding roofs) to the proposed dams will total approximately 2.1 hectares.

Preliminary estimates of the supply available from these storages have been made using the available catchment and storage information, and the rainfall and evaporation information from Silo Datadrill. The runoff into the storages has been estimated using the US Conservation Service USDA model.

The historical no-failure yield has been estimated for each of the storages. The historical no-failure yield of a storage is the maximum annual supply available without any failures in supply occurring over the historical period of analysis – in this case 1950 to 2005. These estimates are listed in Table 4.1.

Table 3 Estimates of Supply available from small dams

Dam	Assumed Capacity (ML)	Historical no-failure Yield (ML/yr)	Comments
Muddy Dam	13.0	4.5	
Dam 3 (north of low-density residential area)	10.5	3.4	
Dam 4	55.0	16.4	
2 proposed storages within the development. (Dam 1 and Dam 2)	15.2	12.2	Ultimate development of catchment assumed. Catchment area upstream of existing storage (Dam 3) excluded.
Totals	**38.7**	**36.5**	

The reliable supply available from the 3 existing and 2 proposed small storages totals 36.5 ML/year (100 kL/day).

The supplementary water demand for the mixed village and village housing type developments totals approximately 44 kL/day (16.1 ML/year), assuming that 50% of the total demand of 88 kL/day is met by the supplementary demand as discussed previously.

The combined supply from Dam 3 and Dam 4 would be sufficient to provide the supplementary water supply for the development. Use of these dams is preferable to using Muddy Dam, because of the distance from the development, and is preferable to using Dam 1 and Dam 2 as they collect runoff from the developed area, which could contain pollutants. Dams 1 and 2 also will be a feature of the development, and if they were used for water supply purposes, drawdown would detract from this function.

Should the supply in Dam 3 and Dam 4 not be sufficient for some reason, it would be possible to utilise storage in Muddy Dam or the proposed dams within the development as a back-up supply.

4.2 Reservoir and Reticulation

The supplementary water supply scheme will include a pump and rising main from each dam to the raw water reservoir and treatment plant located on high ground to the west of the development. Water would be treated near here, and reticulated by gravity to the village housing and mixed village areas. The proposed water supply infrastructure is shown in Figure 4.

4.3 Staging of Water Supply Infrastructure

For the initial stage of the development, a pump would be installed at Dam 4, and the rising main from Dam 4 to the water treatment plant constructed. The initial stage of the treatment plant, reservoir and reticulation to the stage 1 area would also be constructed.

As the village lot housing is supplied by rainwater tanks, development of this area could proceed before the water supply headworks and reticulation, which is required for the village housing and mixed village areas.

Later stages would include augmentation of the treatment plant, reticulation to Stage 2 and 3 areas, the inlet works and pump, and pipe connection from Dam 3 to the rising main.

4.4 Fire-fighting

The reticulation pipework will be sized so as to provide water supply for fire-fighting purposes. For this reason, the water supply network will cover the whole development including the village lot housing area.

A reticulated supply will be constructed for the village housing, mixed village and community areas, and hydrants will be installed in these areas as part of the reticulation network.

At this stage, no reticulated supply is proposed for the village lot development, therefore some special provision will need to be made to locate and connect hydrants in the village lot areas to the water supply network.

It will be necessary to consult with local emergency services to select the locations and layout of the fire hydrants within the development. This consultation could best take place at the more detailed design stage when the development layout is firmed up.

5. EFFLUENT TREATMENT AND RECYCLED WATER USE

5.1 Description

A sewage treatment plant is proposed as part of the development. It is proposed to install a treatment plant that will be capable of producing recycled water of Grade A+ standard. Recycled water of Grade A+ standard can be used for the following purposes:

- toilet flushing, outdoor hosing and washdown;
- garden watering;
- irrigation of public spaces with uncontrolled access;
- irrigation of food crops eaten raw; and
- firefighting purposes.

A package treatment plant that includes biological nutrient removal, ultrafiltration and disinfection in the treatment train would typically be required to produce effluent of this standard. A high quality effluent with low nutrient concentrations (Total Nitrogen of the order of 5 mg/l and Total Phosphorus of the order of 1 mg/l) will be produced.

The plant will be located to the north of the development, near a disused quarry. As a significant portion of the site drains eastward, a pump station located in the eastern part of the site will be required to deliver sewage to the treatment plant. The locations of the pump station and the treatment plant are shown in Figure 5.

The plant location is well away from the proposed development (around 500 metres distance) and any neighbouring residences, therefore it is expected that there would be negligible risk of odour problems. The high quality of the effluent will obviate any potential problems relating to odour in the irrigation areas.

While a 240-volt power supply will be available for the treatment plant and relift pumps for the sewerage system, it may be necessary to have a separate back-up power supply as it is understood that the power supply in this area is somewhat unreliable.

5.2 Hydraulic Loading

The total hydraulic loading of the sewage treatment plant is expected to be of the order of 100 to 140 kL/day (36 to 51 ML/yr) for the ultimate development of the site.

This assumes a population of approximately 1000 and a discharge of 140 litres/EP/day. The loading could be less if there were some grey-water reuse for landscaping by individual landholders in the development. This would depend on the local regulations.

5.3 Effluent Disposal Areas

Treatment of the effluent to a standard allowing use for irrigation in areas with unrestricted public access is proposed.

Based on a preliminary assessment of the loading rate, and the typical quality of effluent, an area of approximately 13.5 hectares would be required for land disposal of the effluent without causing detriment to the soils through excessive hydraulic and nutrient loading.

The actual minimum disposal area would need to be determined when more information was obtained on the soil types and soil properties in the proposed disposal areas, the standard of the treatment, and the quality of effluent.

The treated effluent could be reused for landscape irrigation of areas such as the town green, road verges and the sports and recreation area, which appear to have a total area of approximately 2.5 hectares. A market garden is planned as part of the development, and this could be irrigated with the recycled water. The treated effluent could also be provided at some appropriate charge to individual landholders for their landscaping requirements. Areas suitable for effluent irrigation have been identified to the north and east of the development. These areas are shown on the sewerage infrastructure plan Figure 5.

It appears that there will be adequate areas available for disposal of the treated effluent.

Irrigation of the village green and sports oval areas will most likely be by sub-surface drip, or a pop-up sprinkler system. The irrigation areas outside the development area would probably be irrigated by a solid-set irrigation system or by travelling irrigators. The choice of system will by determined by factors such as land slope, soil type, public access, and cost.

5.4 Wet Weather Storage Requirements

A wet weather storage would be required to store the treated effluent during wet weather periods when irrigation was not possible, and to act as buffer to absorb differences in plant output, and irrigation use. The size of wet weather storage required depends generally on the allowable frequency of overflow of the storage, the area irrigated and climatic factors.

The New South Wales EPA effluent irrigation guidelines indicate that for full reuse schemes where there is no effective discharge to receiving waters and the strength of the effluent is low, uncontrolled releases from the wet weather storage may be allowed in 50% of years.

Some preliminary analyses have been completed using the Medli model to size the buffer storage, so that uncontrolled overflows do not occur in more than 50% years. Medli is a model for designing and analysing an effluent disposal system using land irrigation. It was developed for the CRC for Waste Management and Pollution Control.

Preliminary information on soil and crop types was assumed for the analysis. It was determined that for the ultimate development, with 51 ML/year effluent production, and irrigation of 13.5 hectares, a buffer storage of approximately 6.6 ML would be required. This is approximately 47 days' storage. If the irrigation area were larger, the wet weather storage required could be smaller. The irrigation area and wet weather storage could be refined at a more detailed planning and design stage.

The preliminary Medli analysis indicated that with an irrigation area of 13.5 hectares, there would be negligible risk of nutrient build-up in the soil. This is to be expected because of the proposed high level of treatment with biological nutrient removal.

5.5 Staging of Sewerage Infrastructure

The development is planned to proceed in three stages. The approximate effluent output, area irrigated and wet weather storage requirements for each of these stages are listed in Table 4.

Table 4 Staging of Effluent Irrigation Works

Stage	Total EP	Effluent Production (ML/yr)	Irrigation Area Required (hectares)	Wet Weather Storage Capacity (ML)
1	609	31.1	8	4
2	768	39.3	9.5	4.8
3	952	48.6	13.5	6.6

Figure 5 is a preliminary layout showing location of the sewage pump stations, rising mains, treatment plant, effluent storages, irrigation areas and sewer lines.

The stage 1 development will include the sewers in Stage 1 area, stage 1 of the treatment plant, rising main to wastewater treatment plant, wet weather storage tanks and irrigation areas adjacent to the plant, as well as the irrigation areas (sports field and village green) within the development.

Later stages would include plant augmentation, extension to the sewers, gravity main from the storage tank to additional wet weather storage and irrigation areas to the northeast of the site.

6. SUMMARY & CONCLUSION

A preliminary investigation of water supply options for the Nightcap Village development has been carried out. The development will have to provide its own water supply as it is remote from any existing potable supply reticulation networks.

Water supply to the development could be provided from a variety of sources as follows.

a) Rainwater Tank Supply

Rainwater tank supply would provide the sole supply to the low-density residential component. A minimum 45-kilolitre rainwater tank storage would be required, and the roof area draining to the rainwater tank or tanks should be maximised. Ideally a roof catchment of 150 m^2 or more should be provided. A first flush device should be fitted, and it is recommended that UV treatment units should be installed to treat at least the potable component.

Rainwater tank supply would provide approximately 50% of the supply to the village housing and mixed village developments. It is recommended that the rainwater tank supply be connected to the kitchen and shower/bath outlets. A minimum rainwater tank capacity of 20 kilolitres per residence would be required. The tank could be integrated in the design of the residence. The roof area draining to the tank should be maximized, ideally 90 m^2 or more. If individual tanks are considered undesirable, then a larger in-ground tank would be constructed to serve a number of residences. This would however require additional reticulation and collection piping.

b) Surface Supply from Small Storages

A treated supply from the existing and proposed surface water storages on the development is proposed. It is recommended that pipelines be constructed from the two existing storages north of the development to an elevated raw water storage just west of the site, from where it will be treated to potable standard and reticulated by gravity to the village housing, mixed village and other communal parts of the development. The supply is estimated to be sufficient to provide about 50% of the requirements for the village style housing. This supply would be connected to the toilet, laundry and minor external outlets in each residence. The reticulation network would be sized to provide fire-fighting flow requirements.

The capacities of the existing and proposed small storages have been estimated approximately. Better survey information would be required to confirm the capacities adopted in the analysis. The storage to the south west of the development and the two proposed storages within the development could be used as a temporary supply if the two storages to the north could not provide adequate supply during drought periods.

c) Effluent Treatment and Recycled Water Supply

A wastewater treatment plant will need to be constructed to treat sewage effluent from the development. With ultimate development of the site, a plant with a capacity of approximately 50 ML/year will be required. The proposed location for the plant is to the north of the site. A buffer storage with approximate capacity of 6.6 ML would be required for wet weather storage, and a minimum area of approximately 13.5 hectares would be required for land disposal of the effluent. Adequate areas exist within and close to the development for land disposal.

Recycled water (treated to an appropriate standard) from the treatment plant will be used for landscape irrigation of areas such as the sports and recreation area, and the village green. Recycled water from this plant could also be reticulated to individual residences for use in toilet flushing or be sold to individual landholders within the development for their landscape irrigation requirements, however this would require additional reticulation works.

FIGURES

Scale 1:150,000 (A4)

FIGURE 1
NIGHTCAP URBAN VILLAGE
LOCALITY PLAN

© Cardno (Qld) Pty Ltd All Rights Reserved 2006.
Copyright in the whole and every part of this drawing belongs to Cardno (Qld) Pty Ltd and may not be used, sold, transferred, copied or reproduced in whole or in part in any manner or form or on any media, to any person other than by agreement with Cardno (Qld) Pty Ltd.

This document is produced by Cardno (Qld) Pty Ltd solely for the benefit of and use by the client in accordance with the terms of the retainer. Cardno (Qld) Pty Ltd does not and shall not assume any responsibility or liability whatsoever to any third party arising out of any use or reliance by third party on the content of this document.

Rev: Orig. Date: 30 June 2006

Project No.: 3500/53

Peter Van Lieshout

PRINT DATE: 03 July, 2006 - 11:49am

CAD FILE: I:\3500-53\ACAD\Investigation of water supply & effluent disposal options\Figure 1 - Locality Plan.dwg
XREF's: xr-Cadastre_study_area MGA94, xr-NSW Topo Maps

Cardno

Master Plan Image Sourced from: Malcolm Middleton Architects Pty Ltd.

N.T.S

FIGURE 2
NIGHTCAP URBAN VILLAGE
MASTER PLAN

© Cardno (Qld) Pty Ltd All Rights Reserved 2005.
Copyright in the whole and every part of this drawing belongs to Cardno (Qld) Pty Ltd and may not be used, sold, transferred, copied or reproduced in whole or in part in any manner or form or on any media, to any person other than by agreement with Cardno (Qld) Pty Ltd.

This document is produced by Cardno (Qld) Pty Ltd solely for the benefit of and use by the client in accordance with the terms of the retainer. Cardno (Qld) Pty Ltd does not and shall not assume any responsibility or liability whatsoever to any third party arising out of any use or reliance by third party on the content of this document.

Rev: Orig. Date: 30 June 2006

Project No.: 3500/53

Peter Van Lieshout

Cardno

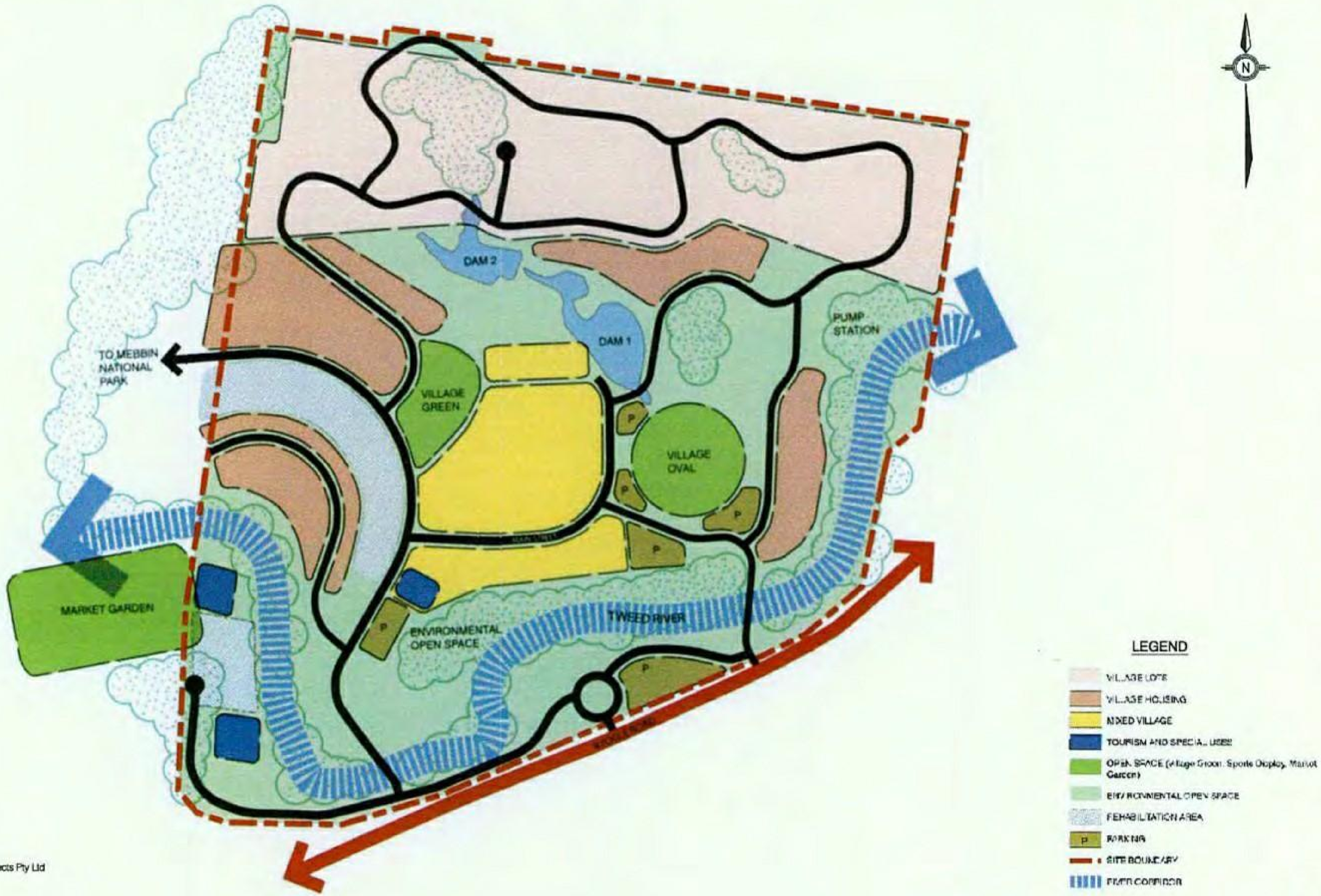


Image Sourced from: Malcolm Middleton Architects Pty Ltd

N.T.S

FIGURE 3
NIGHTCAP URBAN VILLAGE
STAGING PLAN

© Cardno (Qld) Pty Ltd All Rights Reserved 2006.
Copyright in the whole and every part of this drawing belongs to Cardno (Qld) Pty Ltd and may not be used, sold, transferred, copied or reproduced in whole or in part in any manner or form or on any media, to any person other than by agreement with Cardno (Qld) Pty Ltd.

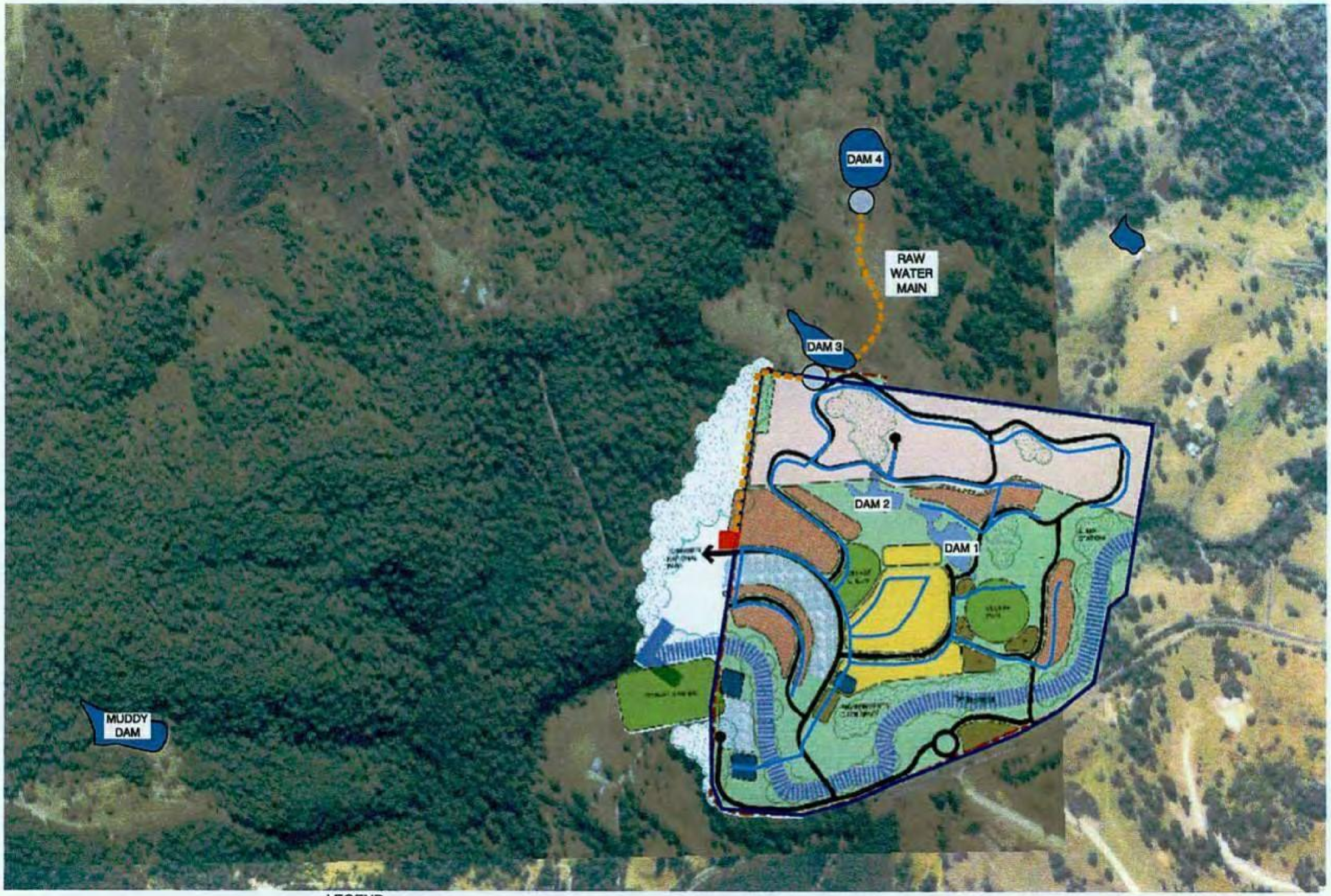
This document is produced by Cardno (Qld) Pty Ltd solely for the benefit of and use by the client in accordance with the terms of the retainer. Cardno (Qld) Pty Ltd does not and shall not assume any responsibility or liability whatsoever to any third party arising out of any use or reliance by third party on the content of this document.

Rev: Orig. Date: 30 June 2006

Project No.: 3500/53

Peter Van Lieshout

Cardno



Staging Plan Image Sourced from: Malcolm Middleton Architects Pty Ltd.
Aerial Photograph Taken : 26.06.05

© Cardno (Qld) Pty Ltd All Rights Reserved 2006.
Copyright in the whole and every part of this drawing belongs to Cardno (Qld) Pty Ltd and may not be used, sold, transferred, copied or reproduced in whole or in part in any manner or form or on any media, to any person other than by agreement with Cardno (Qld) Pty Ltd.

This document is produced by Cardno (Qld) Pty Ltd solely for the benefit of and use by the client in accordance with the terms of the retainer. Cardno (Qld) Pty Ltd does not and shall not assume any responsibility or liability whatsoever to any third party arising out of any use or reliance by third party on the content of this document.

Rev: Orig. Date: 30 June 2006

LEGEND

- Dam
- Treatment Plant and Reservoir
- Pump Station
- Water Line

75 0 75 150 225 300 375m 1:7500

Scale 1:10,000 (A3)

FIGURE 4

NIGHTCAP URBAN VILLAGE

PROPOSED WATER SUPPLY INFRASTRUCTURE

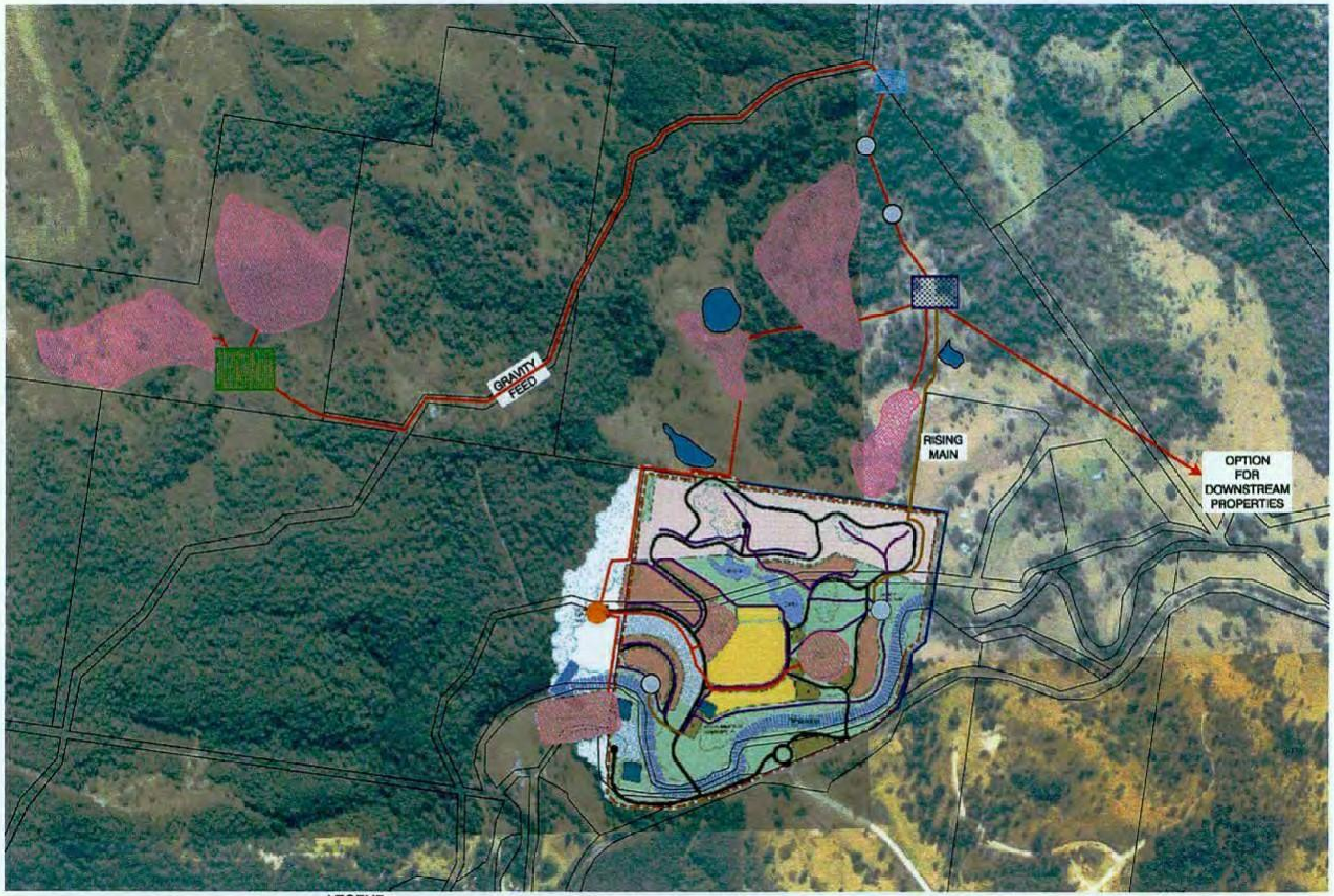
Project No.: 3500/53

Peter Van Lieshoult

CAD FILE: [illegible] Investigation of water supply & effluent disposal options\Figure 4 - Proposed Water Supply Infrastructure.dwg
XREF's

PRINT DATE: 24 July 2006 - 4:53pm

Cardno



Staging Plan Image Sourced from: Malcolm Middleton Architects Pty Ltd.
Date of Aerial photographs : 26-06-05

© Cardno (Qld) Pty Ltd All Rights Reserved 2006.
Copyright in the whole and every part of this drawing belongs to Cardno (Qld) Pty Ltd and may not be used, sold, transferred, copied or reproduced in whole or in part in any manner or form or on any media, to any person other than by agreement with Cardno (Qld) Pty Ltd.

This document is produced by Cardno (Qld) Pty Ltd solely for the benefit of and use by the client in accordance with the terms of the retainer. Cardno (Qld) Pty Ltd does not and shall not assume any responsibility or liability whatsoever to any third party arising out of any use or reliance by third party on the content of this document.

Rev: Orig. Date: 30 June 2006

Peter Van Lieshoult

CAD FILE: I:\3500-53\ACAD\Investigation of water supply & effluent disposal options\Figure 5 - Proposed Sewerage Infrastructure.dwg
XREF's:

LEGEND

- Potential Irrigation Area
- Dam
- Woodlot Water Storage
- High Level Storage Tanks
- Sewage Treatment Plant and Wet Weather Storage Tanks
- Pump Station
- Sewer Line
- Storage for Treated Water
- Recycled Water Main to Irrigation Areas
- Rising Main to STP

100 0 100 200 300 400 500m
1:10,000

Scale 1:10,000 (A3)

FIGURE 5

NIGHTCAP URBAN VILLAGE

PROPOSED SEWERAGE INFRASTRUCTURE

Project No.: 3500/53

PRINT DATE: 24 July 2006 - 4:51pm

APPENDIX A

Rainwater Tank – Supply Reliability

Water Balance - Summary of Results **Nightcap Village Development**

Estimates of reliability of supply for a single dwelling supplied by rainwater tank

	Consumption 75 l/EP/day							
Tank Size	2.2 per dwelling							
	Roof Size							
	90 m^2		100 m^2		120 m^2		150 m^2	
(litres)	% time shortfalls	Av Annual Shortfall (kL)	% time shortfalls	Av Annual Shortfall (kL)	% time shortfalls	Av Annual Shortfall (kL)	% time shortfalls	Av Annual Shortfall (kL)
10000	8.0%	4.5	6.6%	3.8	5.0%	2.8	3.5%	2.0
15000	3.6%	2.0	2.6%	1.5	1.5%	0.9	0.9%	0.5
20000	1.0%	0.6	0.5%	0.3	0.3%	0.2	0.2%	0.1
30000	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0
40000								
50000								

	Consumption 120 l/EP/day							
Tank Size	2.2 per dwelling							
	Roof Size							
	90 m^2		120 m^2		150 m^2		200 m^2	
(litres)	% time shortfalls	Av Annual Shortfall (kL)	% time shortfalls	Av Annual Shortfall (kL)	% time shortfalls	Av Annual Shortfall (kL)	% time shortfalls	Av Annual Shortfall (kL)
10000			17.6%	15.9	13.0%	11.8	9.2%	8.4
15000			8.3%	7.6	5.0%	4.5	2.8%	2.5
20000			3.5%	3.1	1.2%	1.1	0.4%	0.4
30000			0.8%	0.8	0.1%	0.0	0.0%	0.0
40000			0.3%	0.3	0.0%	0.0	0.0%	0.0
50000			0.0%	0.0	0.0%	0.0	0.0%	0.0

	Consumption 150 l/EP/day							
Tank Size	2.2 per dwelling							
	Roof Size							
	90 m^2		120 m^2		150 m^2		200 m^2	
(litres)	% time shortfalls	Av Annual Shortfall (kL)	% time shortfalls	Av Annual Shortfall (kL)	% time shortfalls	Av Annual Shortfall (kL)	% time shortfalls	Av Annual Shortfall (kL)
10000					20.4%	23.2	14.7%	16.8
15000					15.1%	17.2	9.8%	11.2
20000					11.4%	12.9	6.6%	7.5
30000					6.1%	6.8	2.6%	3.0
40000					2.8%	3.1	0.5%	0.6
45000					1.6%	1.8	0.1%	0.2
50000					0.8%	1.0	0.0%	0.0